The chemistry of mercury deposition in the Arctic

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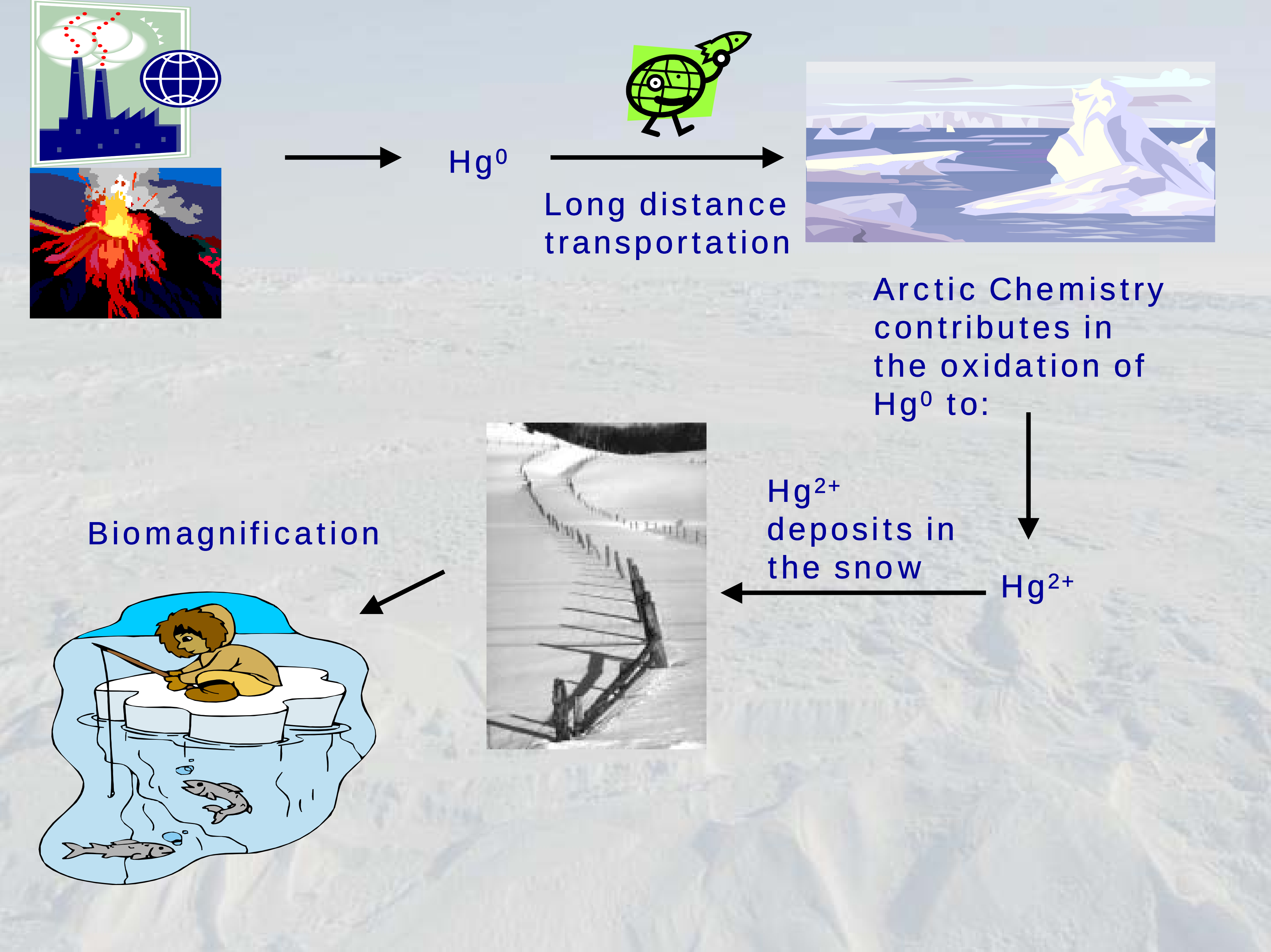
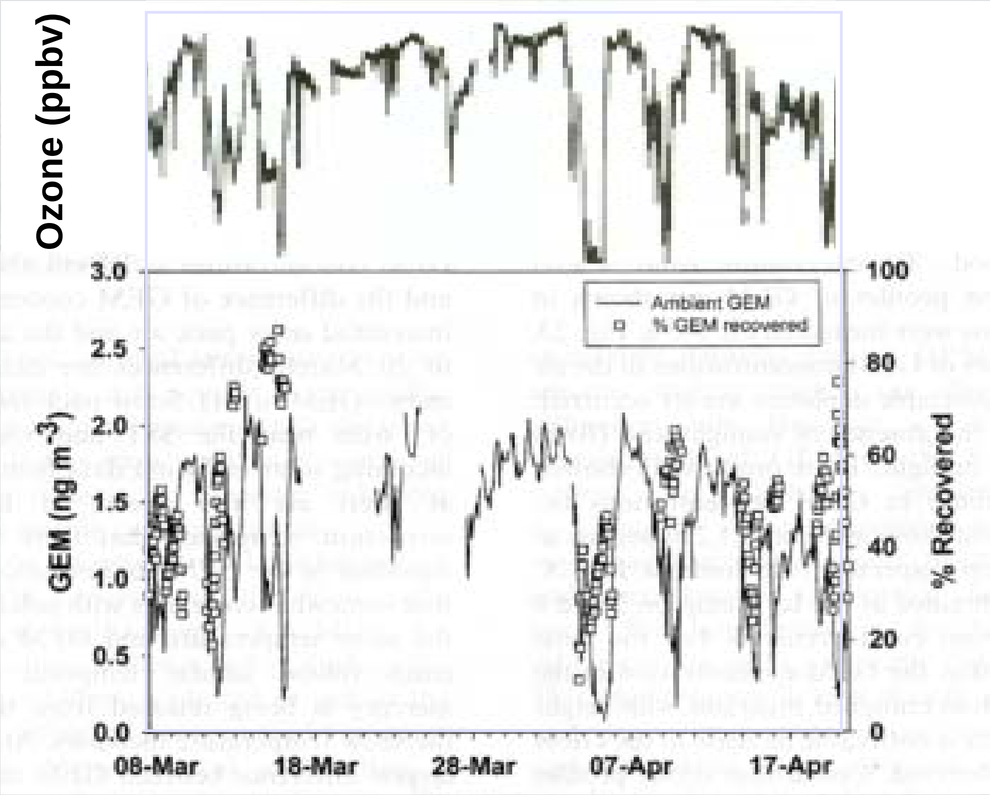


Hg^0
Long distance transportation
Arctic Chemistry contributes in the oxidation of Hg^0 to:
Hg^{2+}
Hg^{2+} deposits in the snow
Biomagnification

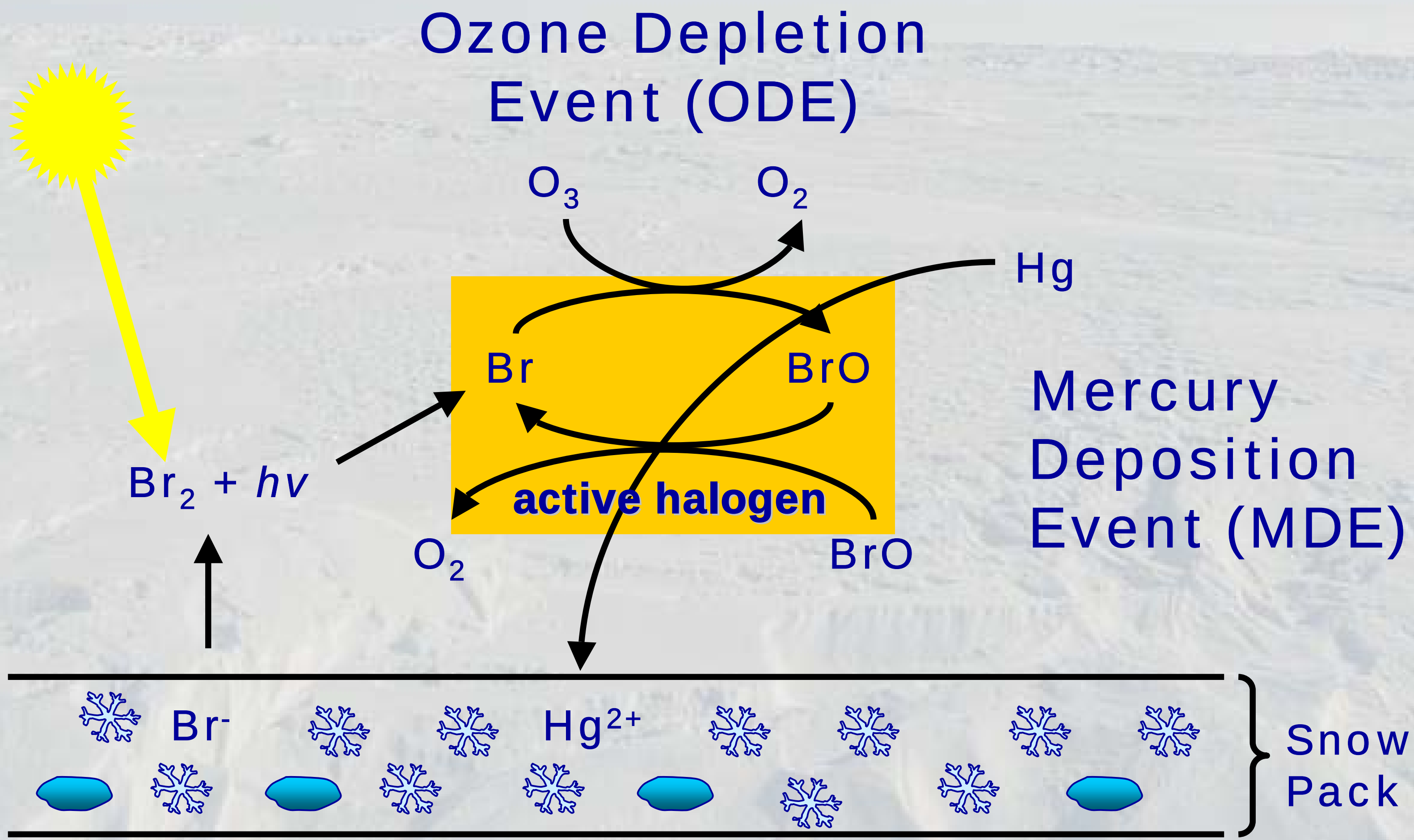
Mercury and Ozone depletion

Mercury deposition and surface ozone depletion events are associated together in an autocatalytic cycle initiated by activated halogens.



Data from Schroeder et al. and Bottenheim et al., *Atmos. Env.* 2002.

Proposed Mechanism



Summary of Background

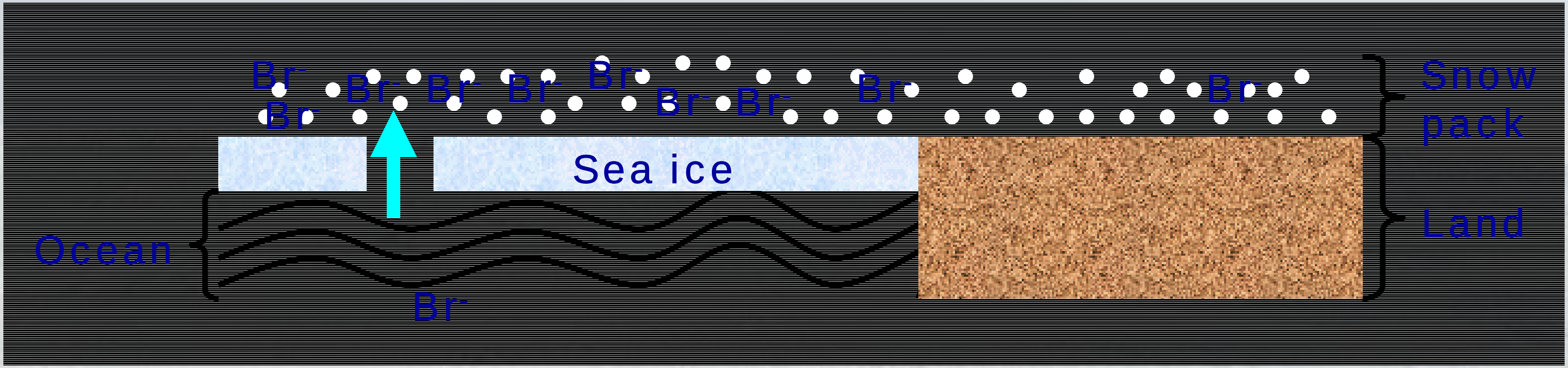
- Important processes occurring: MDE and ODE
- Key players: Hg, ozone, Br^-, BrO
- Place: Arctic
- Time: Spring time, after polar sunrise
- Medium: Snow and surface air

Field work in Barrow, 2004

Primary Questions

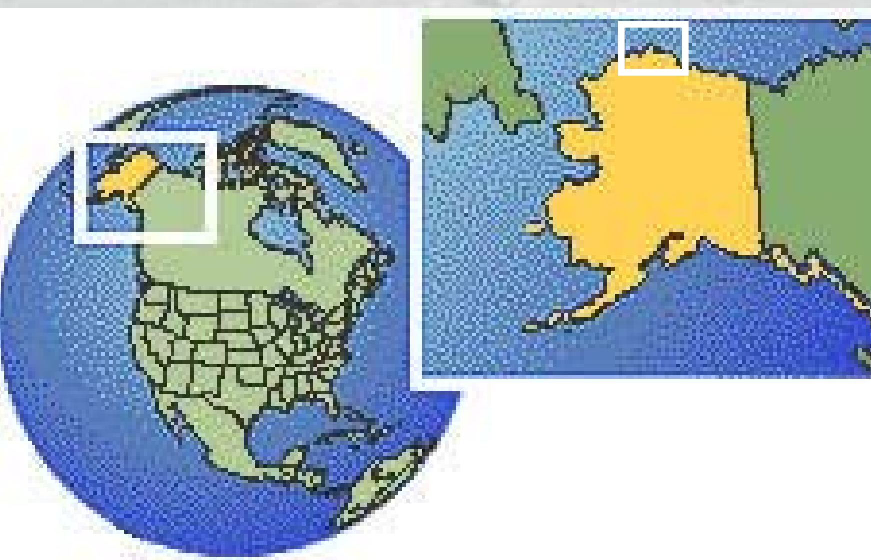
- How does the active halogen mechanism couple to mercury deposition?
- How much of the global burden of Hg is deposited to Arctic marine and terrestrial ecosystems?
- What is the relation between snow composition and air chemistry?
- How do meteorological conditions affect ozone depletion and mercury deposition events?

Sea—Land contrast



- **Bromine has a marine source**
- **We expect active MDE chemistry offshore and a gradient decreasing intensity inland**
- **Sample along a transect offshore to onshore**

Bromide, Mercury and Ozone, 2004



Snow Samples from 2004

- Traveled transect 3 phases:
  Phase I: 29 Feb – 5 Mar (early MDE season)
  Phase II: 31 Mar – 13 Apr (peak MDE)
  Phase III: 7 May – 11 May (end MDEs)
- Sampled 50 total Hg samples (in triplicate)
- Sampled 100 ion samples (in triplicate) – will analyze for major anions and cations with focus on Br^-.

⇐ Bill Simpson (UAF) Sampling blowing snow

Matthew Sturm (CRREL) Sampling snow for ions ⇒

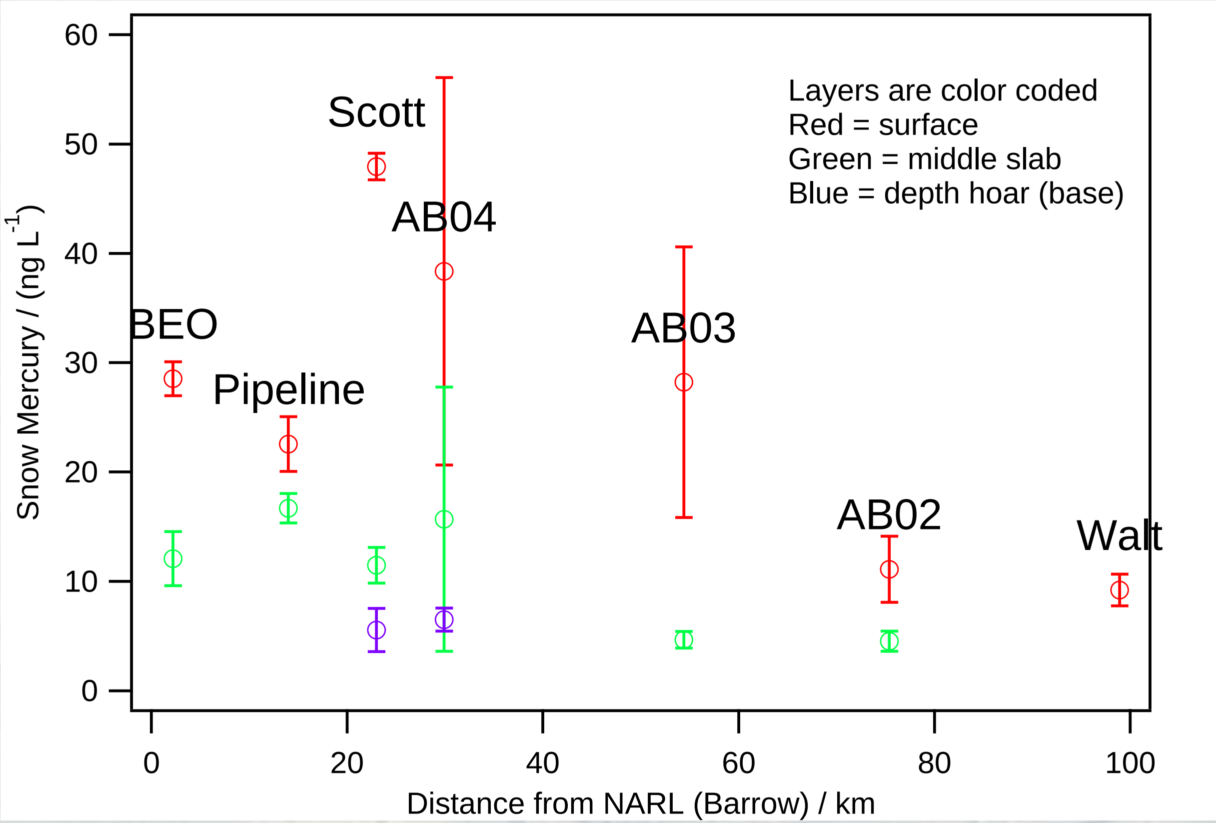
⇐ Anne-Sophie Taillandier (Grenoble, France) Sampling for Mercury

Dan Elsberg (UAF) Measuring temperature ⇒

⇐ An open lead offshore of Barrow. Frost flowers are on the bottom left. We sampled these frost flowers.

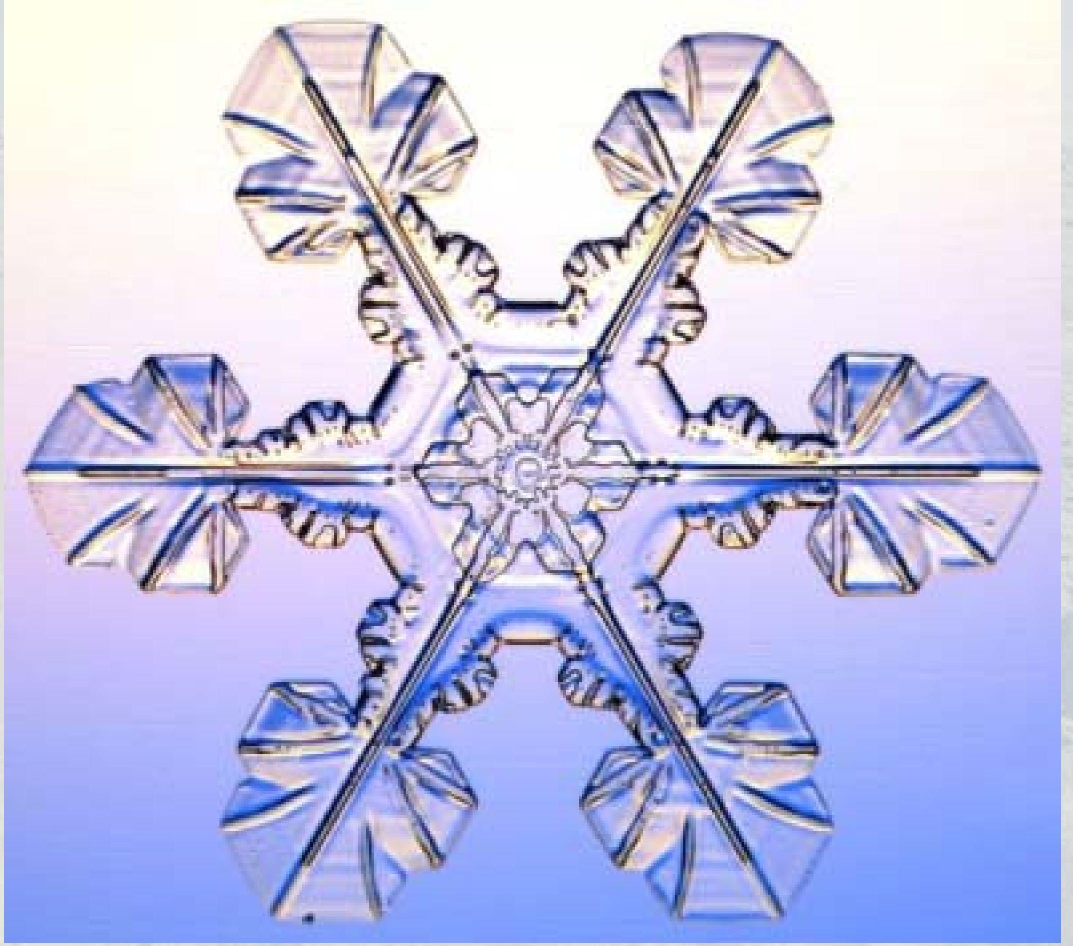
Florent Dominé (Grenoble, France) Sampling frost flowers ⇒

Phase I Snow Mercury data



- Data from Phase I transect – early in MDE season
- Shows Hg falloff from coast

How is Br^- distributed in snow crystals?



Analyze samples from Barrow using TOF-SIMS with Dr. James Cowin, PNNL

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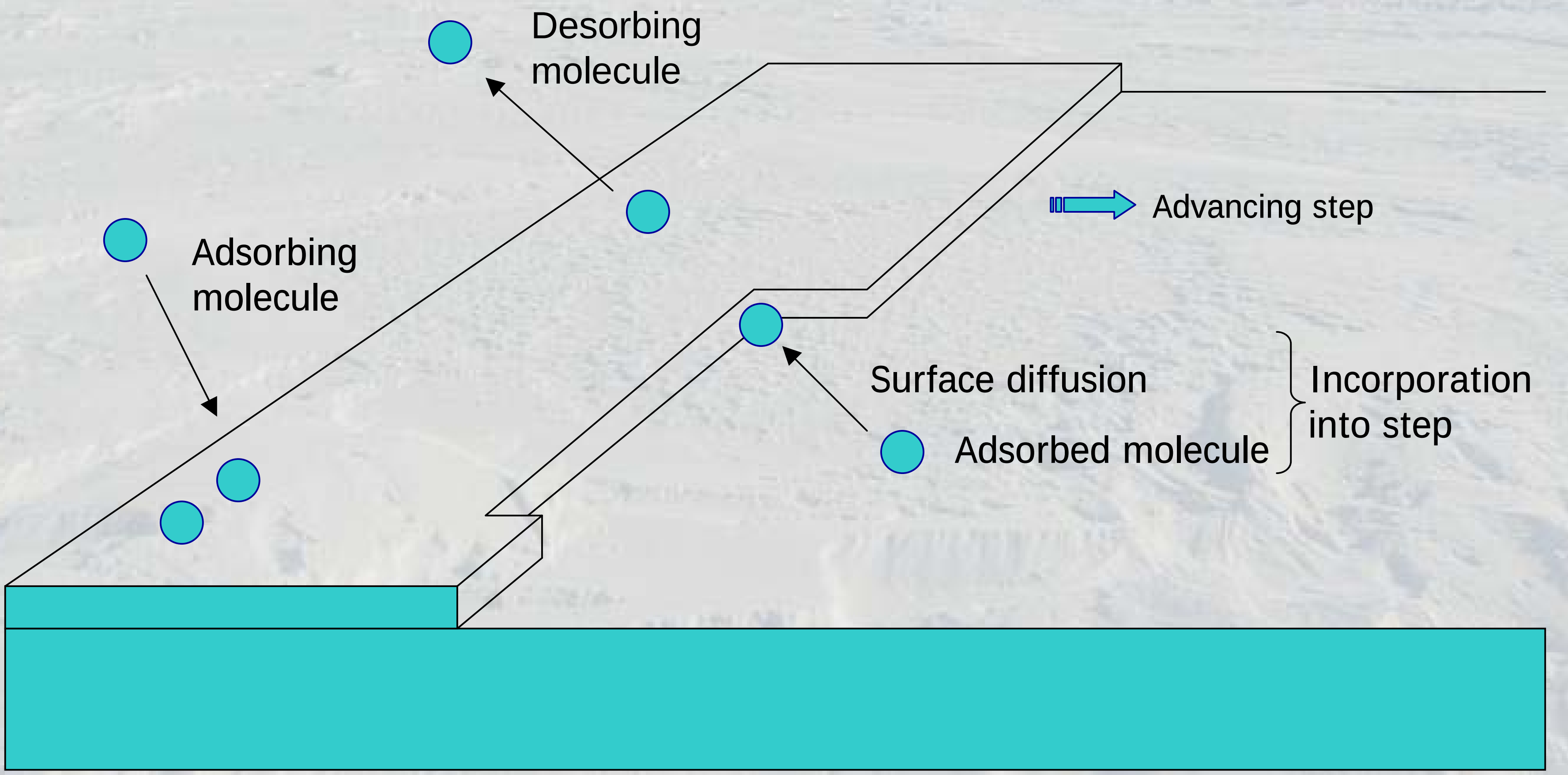
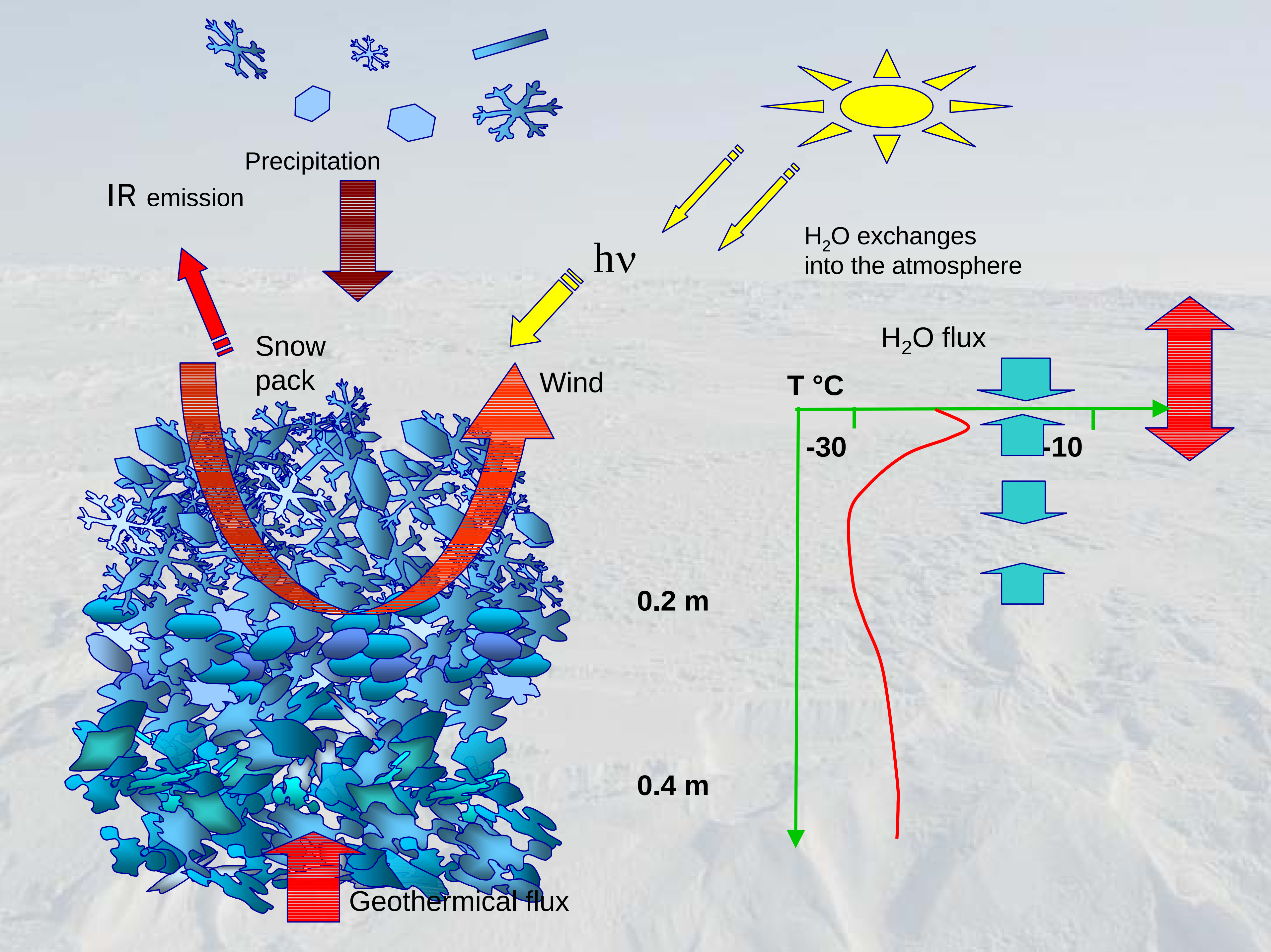
Incorporation of compounds into the snow pack



Snow Metamorphism

- Physical processes affecting the snow pack, and resulting in changes in:
  - Grain sizes
  - Grain shape
  - Snow density
  - Other physical properties of snow like permeability, albedo
  - Chemical composition of snow


Precipitation
IR emission
hν
H_2O exchanges
into the atmosphere
Snow
pack
Wind
H_2O flux
T °C
-30
-10
0.2 m
0.4 m
Geothermical flux